Non-Destructive Assessment of Soft Filter Cake

A. Raheem[1], C. Vipulanandan[1], Ph.D., P.E. and B. Head[2]
[1]Center for Innovative Grouting Material and Technology (CIGMAT)
Department of Civil and Environmental Engineering
University of Houston, Houston, Texas 77204-4003
E-mail: amraheem@uh.edu, cvipulanandan@uh.edu Phone: (713) 743-4278
[2]Program Manager – RPSEA, Sugar Land, Texas 77478

Abstract: The nondestructive assessment is the best way to characterize the soft filter cake for formation damage application. Hence, experimental and analytical modeling was performed to correlate both pulse velocity and electrical resistivity of soft filter cake using 2% to 10% bentonite drilling mud. The pulse velocity and electrical resistivity had a linear and nonlinear relationship with the bentonite content respectively. Finally, a correlation between pulse velocity and electrical resistivity was also provided.

1. Introduction: Formation damage, a common problem related with field operations, is often a main factor in reducing the productivity of a well in a petroleum reservoir (Liu and Civan 1995). Numerous laboratory and field studies indicate that formation damage occurs during many phases of reservoir development, drilling, completion, work-over, production, stimulation, water-flooding or improved oil recovery (Almon and Davies 1981). It has been recognized that the major cause of damage is the transport of fine particles in porous media.

2. Objective: The main objective was to back calculate the soft cake content using nondestructive tests through both pulse velocity and electrical resistivity methods. The study was limited for soft cake with the bentonite content of 2% to 10%.

3. Materials and Methods: Soft cake with 2% to 10% of bentonite was used. The ultrasonic pulse velocity and electrical resistivity were studied using ultrasonic device and 2 probe electrical resistivity methods respectively.

4. Mathematical Model: The following mathematical models were used to back calculate the bentonite content from electrical resistivity and pulse velocity methods:

$$\rho - \rho_o = \frac{Bent.(\%)}{\mathrm{A} + \mathrm{B} * \mathrm{Bent.}(\%)}, \ 2\% < \mathrm{Bent.} < 10\% \quad (1)$$

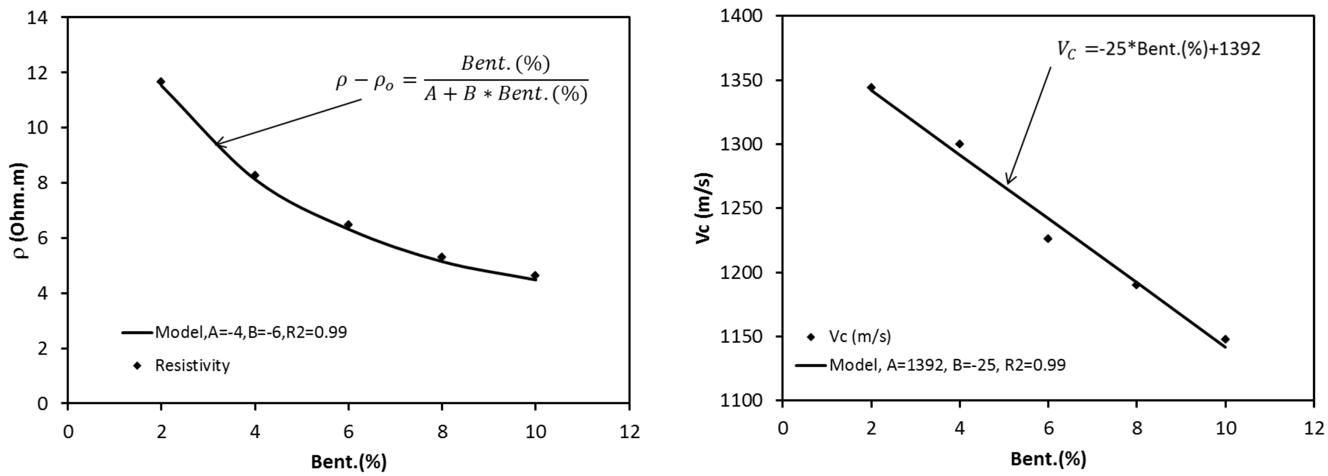
$$V_C = \mathrm{C} + \mathrm{D} * \mathrm{Bent.}(\%) \quad (2)$$

Where: ρ is electrical resistivity; ρ_o initial electrical resistivity, A, B, C and D are model parameters; and Vc is the compression wave velocity.

5. Results: Both electrical resistivity and pulse velocity can be used to back calculate the bentonite content in the soft cake with a high precision through both equations 1 and 2 as it can be seen in Figure 1(a & b). Through this study, a linear pulse velocity vs. electrical correlation can be concluded as follows (Figure 2):

$$V_C = \mathrm{E} + \mathrm{F} * \rho \quad (3)$$

Where E and F are model parameters.



(a) (b)

Figure 1. (a) Resistivity vs. Bentonite, (b) Compression Wave Velocity vs. Bentonite.

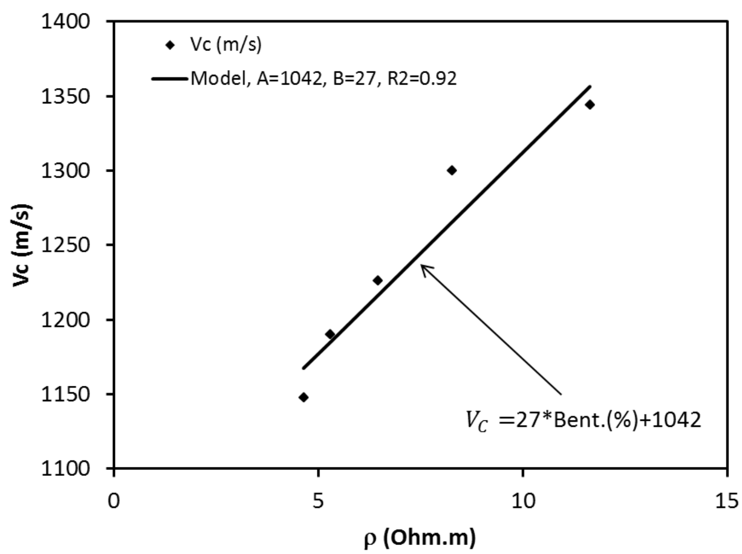


Figure 2. Pulse Velocity vs. Electrical Resistivity Relationship.

6. Conclusion: Nondestructive tests (electrical resistivity and pulse velocity) can be used preciously to back calculate the bentonite contents in any soft cake. Useful pulse velocity vs. electrical resistivity of soft cake can be concluded.

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8. References:

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